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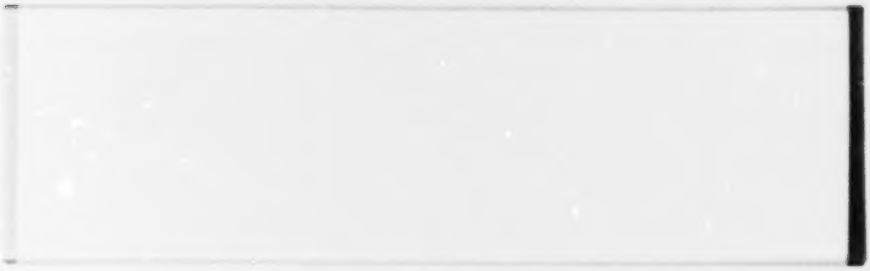

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A CERCHAR HARDNESS TEST PROGRAM METHODOLOGY DEVELOPED FOR THE SYDNEY COALFIELD, N.S.

M.L. Musial, G.R. Corbett and T.R.C. Aston
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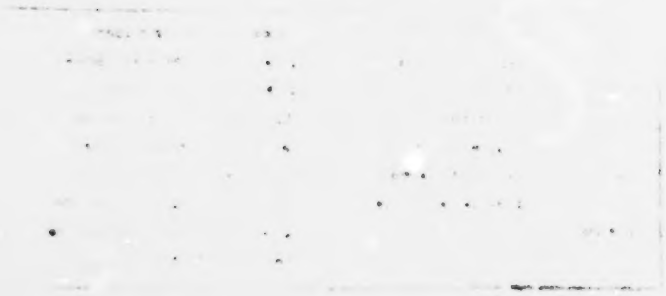

A CERCHAR HARDNESS TEST PROGRAM METHODOLOGY DEVELOPED FOR THE SYDNEY COALFIELD, N.S.

by

M.L. Musial*, G.R. Corbett** and T.R.C. Aston***

ABSTRACT

This report outlines the test procedures currently being developed at the Cape Breton Coal Research Laboratory to establish a rock hardness index system/data base for use in the Sydney Coalfield, N.S. The establishment of a rock hardness index system is considered important since it will allow the performance of rock cutting equipment to be more effectively monitored.

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MÉTHODE DE DÉTERMINATION DE LA DURETÉ CERCHAR MISE AU POINT POUR LE BASSIN HOUILLER DE SYDNEY (N.-É.)

par

M.L. Musial*, G.R. Corbett** et T.R.C. Aston***

RÉSUMÉ

Ce rapport décrit brièvement les méthodes d'essai actuellement mises au point au Laboratoire du Cap-Breton des Laboratoires de recherche sur le charbon, en vue d'établir une base de données et un système d'indice de dureté des roches destinés à être utilisés dans le bassin houiller de Sydney (N.-É.). L'établissement d'un tel système d'indice de dureté est important, estime-t-on, car on pourra alors contrôler de façon plus efficace la performance des haveuses.

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INTRODUCTION

Rock cuttability can be predicted by means of laboratory tests developed by CERCHAR of France (1). CERCHAR hardness and abrasivity testing is undertaken on samples of the stone which is to be bored or cut. Using these two test procedures, the performance of the rock cutting equipment can be predicted (2).

The CERCHAR abrasivity test provides a description of the rock sample according to an induced tool wear. An abrasivity stylus is dragged across the sample for an exact distance under a constant load. The wear produced on the stylus tip is measured as a diameter and the measurement converted to a CERCHAR abrasivity index (CAI) (3,4).

The CERCHAR hardness test provides a measurement of rock hardness by measuring the penetration rate into a rock sample by a carbide drill bit under constant load and rpm. The measured penetration rate is equated to a CERCHAR hardness index (CHI), which in turn can predict the compressive strength for the rock sample.

In 1987, a multi-year research program was established by the Cape Breton Coal Research Laboratory (CBCRL) to investigate rock cuttability and machine performance in the Sydney Coalfield, N.S. (5). The initial objectives of this program are to compile a rock abrasivity/hardness data base and index system, developed from the laboratory testing of field samples. This report examines the procedures being developed at CBCRL for the hardness testing program with respect to test methodology and data reporting.

EXPERIMENTAL PROCEDURE

Table 1 lists the equipment used in the hardness testing program. The following procedure is suggested for determining the CERCHAR hardness index for a sample of rock.

All available hardness related literature and operational manuals should be read prior to and in preparation for hardness testing. Hardness bits should be checked for flaws such as nicks or gouges in the bit tips. Any bits containing flaws or nicks should not be used in the testing but resharpened.

Table 1 - Equipment list

1) CERCHAR Hardness Machine
2) Hardness Bits
3) Hardness Bit Holder (developed by CBCRL)
4) Hardness Bit Transportation Case (developed by CBCRL)
5) Dremel Electric Engraver with Diamond Tip
6) Curve Measuring Device for use with Hardness Apparatus

All test bits should be logged and engraved with a reference number prior to use. Figure 1 shows the dimensions and specifications of the bits.

The pretest examination of the hardness bits is necessary to verify that the bit is in good condition before testing, since experience has shown that because of the well defined tip specifications and carbide strength, damage can occur during shipping. A bench top stylus holder and shipping cartons have been developed by CBCRL to facilitate damage free transportation and handling, Figure 2.

The rock sample which is to be tested needs little or no preparation and can either be a core or an irregular lump. Samples should be identified, tagged and logged. The sample should be large enough to ensure that several tests can be performed on it in order to obtain a statistically valid number for the hardness value. Care should be taken to avoid testing a sample which has fractures since an erroneous result could be produced.

The CERCHAR hardness apparatus (Figure 3) should be examined and test run without a sample to ensure that it is operating properly and the recording device is activating. The depth gauge on the hardness machine, which sets the depth of the hole, should be set to 1 cm.

The sample is then secured into the vice of the apparatus and positioned so that the intended drill hole can penetrate 1.0 cm. A previously used hardness bit is placed in the chuck and locked into position. A starter hole should then be drilled in the rock specimen to ensure that there is a sufficiently flat surface for the test measurement.

When the starter hole is made, the machine is stopped and a new unused drill bit placed in the chuck. A chart record is placed on the drum roll and the spindle is activated to obtain an origin line or generatrix.

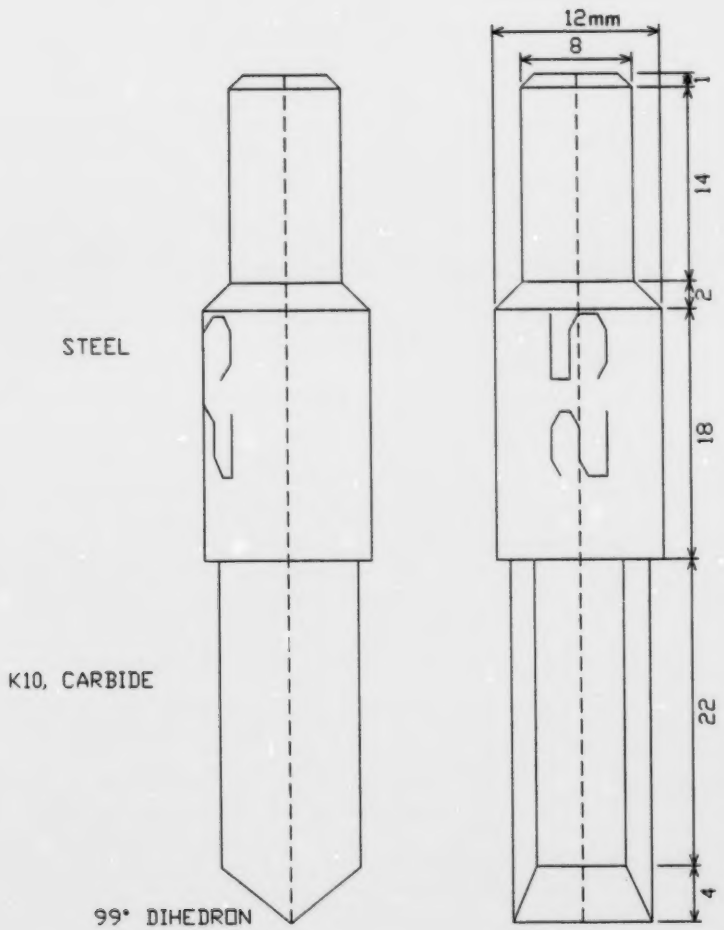
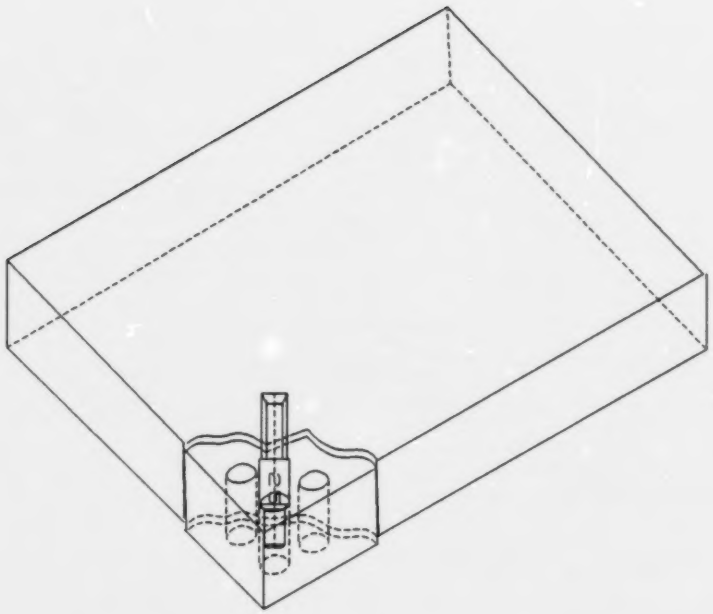
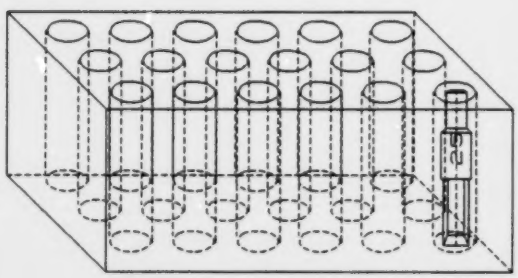


Figure 1 - Engraved hardness bit

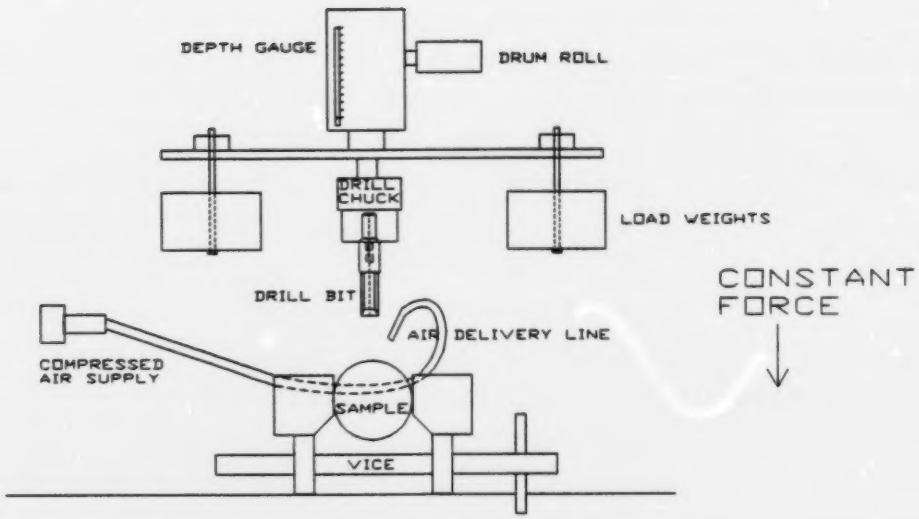


BENCH TOP HOLDER



BALSA SHIPPING CARTON

Figure 2 - Accessories used with hardness testing



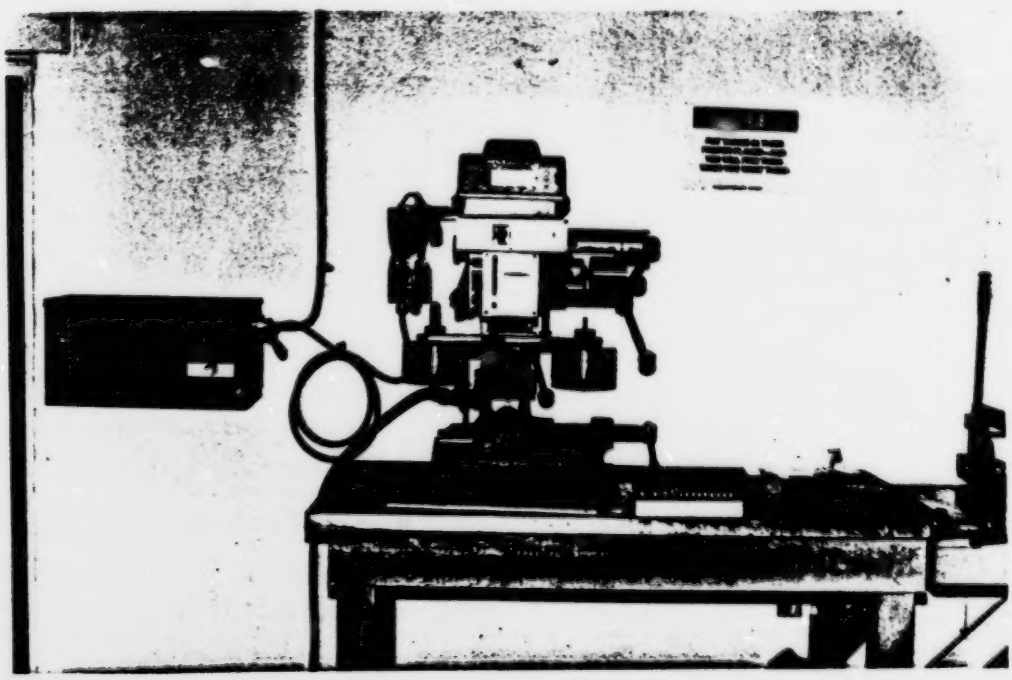


Figure 3 - CERCHAR hardness apparatus

The drill bit is then lowered by means of the drill housing control until the bit comes in contact with the sample, at which point the housing should be locked. The force applied to the drill bit is then only subject to the weight placed on the extended arms. This load is adjustable depending on the test. A heavier load is used for the harder samples; a lighter load for the softer samples. The results are then corrected to the standard load value which is 20 kg (Table 2). Compressed air which is directed at the drill hole, is then turned on to blow any drill debris away from the drilling action. The compressed air is important because without it erroneous results will occur (Figure 4).

The machine is then activated and starts drilling into the sample. The debris is blown away from the hole by the compressed air jet as the drill bit penetrates. While penetration is taking place under the constant preset load, a pen is being pulled across the strip chart record. At the completion of a 1 cm deep hole, a curve exists which represents the penetration rate under constant load, and this is equatable to the CHI.

The strip chart, which can be used for several runs, is then taken off the drum roll (Appendix A). A tangent line is then placed on the strip chart record with the start of the line at the origin. The CERCHAR hardness measuring device is then placed over the chart and lined up with the origin and the CHI read (Figure 5). Depending on the load used, the correction factors listed in Table 2 are used to determine the CHI.

A point-by-point listing of the hardness testing procedure is given in Appendix B.

Table 2 - CHI curve correction table

Load	Weights Applied to Achieve Load	Used For	CHI = Corrected Curve Value
7 kg	No weights applied	Soft Sample	curve value / 3
20 kg	2 x 7 kg	Medium Sample	curve value x 1
40 kg	2 x 16 kg	Harder sample	curve value x 2

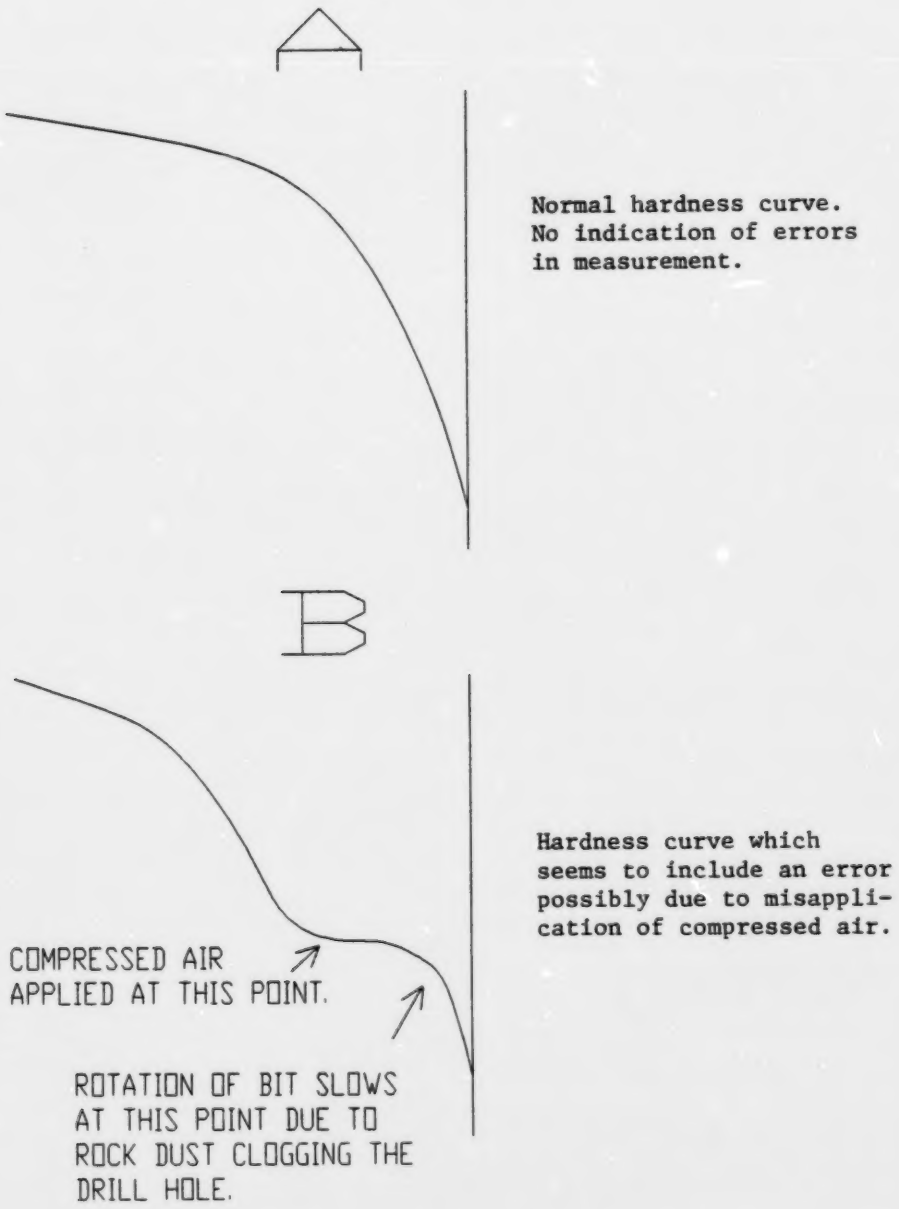


Figure 4 - Hardness curve examples

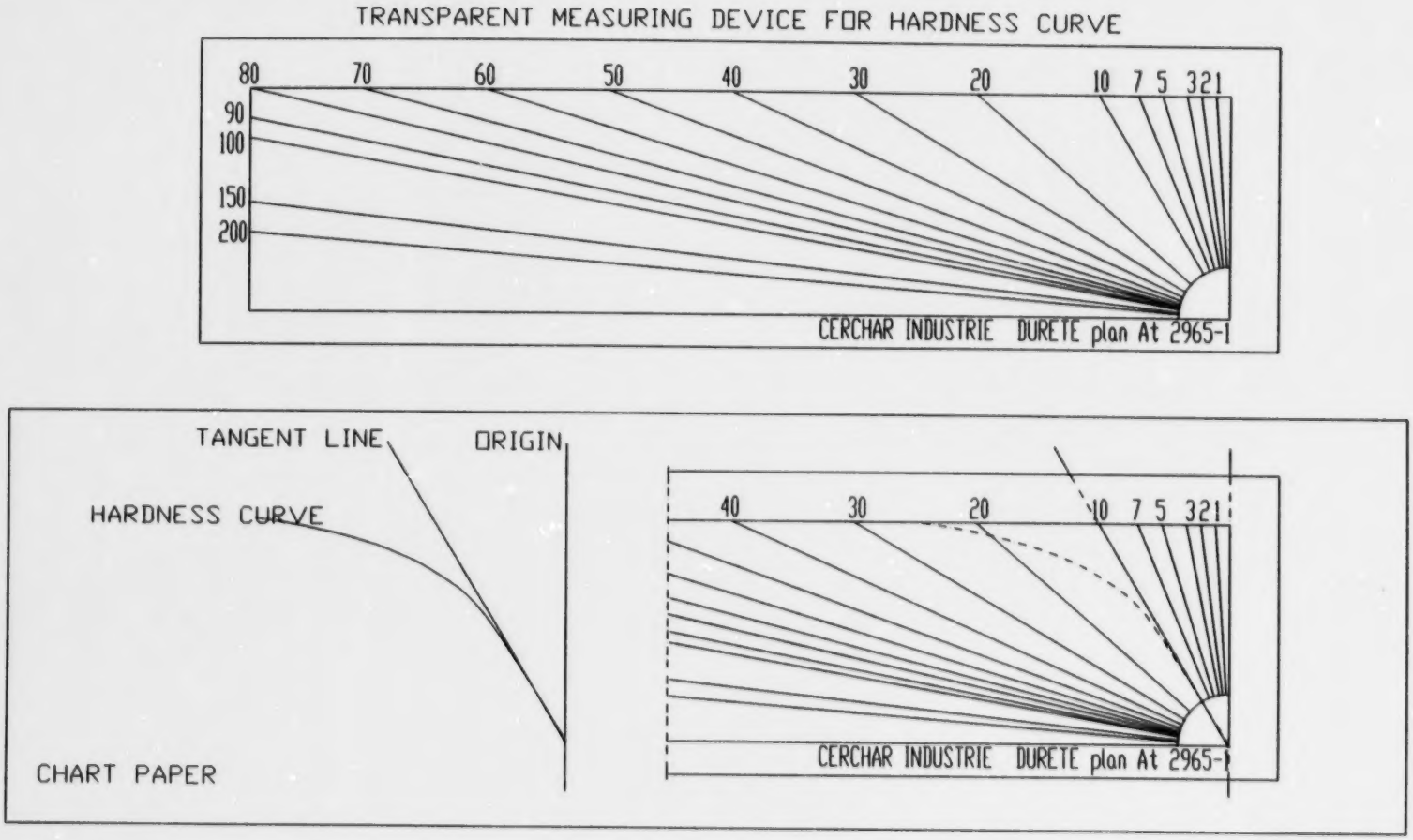


Figure 5 - Hardness curve measurement

REPORTING OF RESULTS

Table 3 is suggested for the reporting of the test results. Care should be taken to try and include as many factors as possible which can influence the hardness measurements, for example sample lamination, cross bedding, foliation, etc. It is essential that all possible factors which may contribute to the hardness results be identified and evaluated.

DISCUSSION

The CERCHAR hardness index is currently being used in France by companies concerned with the problems of rock excavation. It could therefore be used to enhance production rates in the Sydney Coalfield by predicting machine tool wear. However, this requires the establishment of a hardness data base. A testing program should therefore be undertaken on standard rock types from within the Sydney Coalfield which range from very soft to very hard samples. Silica and cement content should also be considered. A hardness index could be determined for approximately 30 types of strata in the Sydney Coalfield thereby allowing easy identification of samples at the work location and allowing machine/pick parameters to be changed more rapidly to meet the cutting conditions.

This report represents the initial phase of hardness testing for samples from the Sydney Coalfield. The procedures listed are an overview and may be adjusted as testing continues. Several tests are planned for a following report which will identify the optimum number of tests available from a bit and give comparisons of hardness values for differing rock types.

REFERENCES

1. Valantin, A. "Investigation of different classical methods for determining the detrimental effects of rocks with regards to machine mining"; Proc. Information Symposium "Excavation Techniques"; Luxemburg; November 28-29, 1973.

Table 3 - Suggested table for reporting results

DATE
SAMPLE ID
LOCATION
COMMENTS ON SAMPLE (FIELD, STORAGE, ETC.)

Sample #	Bit #	Run #	Sample Type	Rock Type	Type Description and Comments	Drill to Bedding Orientation	Drill Load	Measured CHI	Correction Factor	CHI
CBCRL 1	1	1	Core	Sandstone	Laminated	50°, 30°, 0°, etc.	40	15	X 2	30
	2	1			Cross Bedded		40	16	X 2	32
	3	1			Foliated, Etc		40	15	X 2	30
									AVERAGE	31
CBCRL 2	4	1	Lump	Siltstone	Laminated	50°, 30°, 0°, etc.	20	23	X 1	23
	5	1			Cross Bedded		20	25	X 1	25
	6	1			Foliated, Etc		20	26	X 1	26
									AVERAGE	25

2. Howarth, D.F. "Review of rock drillability and borability assessment methods"; Trans. Inst. Min. Metall., Section A, Vol. 95, pp. A191-A202; October 1986.

3. "CERCHAR hardness and abrasivity operations manuals"; Laboratoires du CERCHAR, Centre d'Etudes et Recherches des Charbonnages de France.

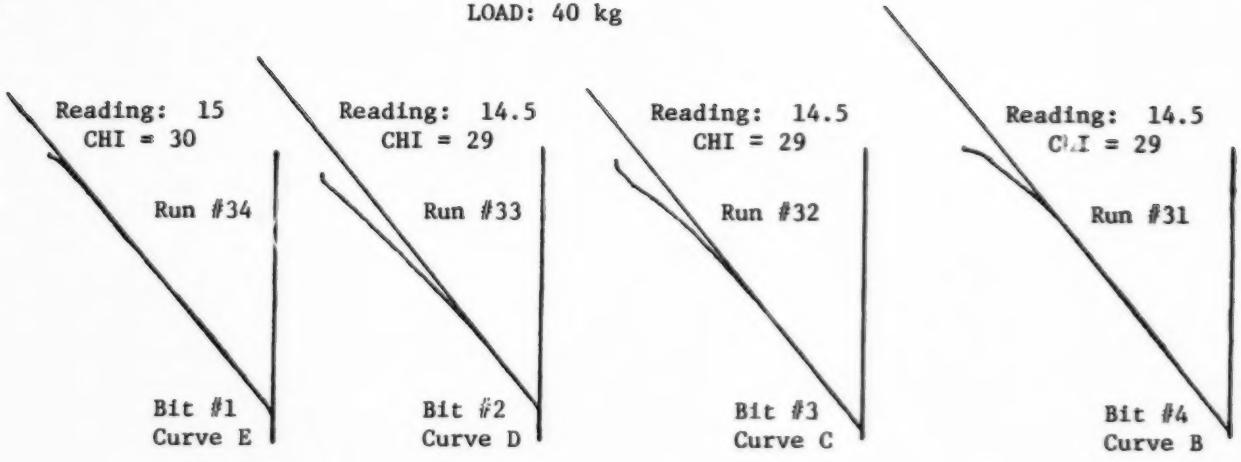
4. Corbett, G.R. and Aston, T.R.C. "A CERCHAR abrasivity test program methodology developed for the Sydney Coalfield, N.S."; CANMET Division Report CRL 88-70(TR); October 1988.

5. Aston, T.R.C. "Proposed CBCRL/CBDC research program to investigate rock cuttability and machine performance in the Sydney Coalfield, N.S."; Division Report CRL 87-56(INT); CANMET, Energy, Mines and Resources Canada.

APPENDIX A

SANDSTONE:

SEPT. 7/88
LOAD: 40 kg



APPENDIX B

PROPOSED HARDNESS TESTING PROCEDURE

1) Ensure the 3-position switch is set at the zero (0) position before applying the main power supply. Set the spindle in place and lock. Raise the drill housing (i.e. the bit chuck) by means of the drill housing control wheel and lock into place.
2) Set test rock in the vice of the hardness apparatus and grip securely. (The rock sample must be sufficiently large). It is not necessary that the surface to be drilled is flat.
3) Insert a <u>used</u> bit into the chuck and tighten with the supplied allen key. Mount a ball pen in the pen holder and keep suspended above the drum roll. Place a recorder chart on the drum roll and fasten.
4) Unlock the spindle by means of the 3-arm handle. Set the pen on the chart recorder. Use the 3-arm hand wheel to actuate the spindle to obtain an origin line on the chart paper.
5) Relock the spindle and unlock the drill housing.
6) Turning the drill housing control wheel bring the locked spindle head close to the sample surface. When the bit comes into contact with the rock, the spindle will automatically unlock.
7) Turn on the compressed air to its maximum and ensure that it is properly directed at the site of the drill hole so that it forcefully clears away the rock dust immediately.
8) Grip the 3-arm handle with the right hand and set the 3-position switch on position one (1) with the left hand. Gently lower the spinning bit into the rock. The bit now penetrates the rock. When the bottom of the hole is perfectly circular (generally obtained at a very shallow depth), set the 3-position switch back to zero. Turn off compressed air. Relock the spindle by means of the 3-arm handle.
9) Unlock the drill housing and raise the bit by means of the drill housing control wheel. Relock the drill housing and remove the bit from the chuck.
10) Insert a new <u>unused</u> bit into the chuck.
11) Bring bit gently into contact with rock at the site of the starter hole as before - steps 5 and 6.
12. Ensure that the ball pen is positioned exactly at the origin. If the pen is not ideally set, maneuver the pen by turning the drill housing control

wheel. Position the pen as desired, hold this position with the left hand and lock the drill housing in place with the right hand.

13) Turn on compressed air to its maximum. Ensure the penetration depth is set to 1.0 cm (see scale on the front of the apparatus).
14) Turn the 3-position switch on to the "rotation and recording" position (position 2). The bit automatically penetrates the rock and the depth of penetration is then recorded as a function of time.
15) Terminate drilling by turning the 3-position switch to zero. Turn off air. Raise pen from chart paper.
16) Raise the bit relock spindle by means of 3-arm handle. Unlock the drill housing and raise bit higher by means of the drill housing control wheel. Relock drill housing.
17) Leave the used bit in the drill chuck to start hole for the next test. Raise ball pen and forward recording drum (set switch to position 2) to re-position chart paper for next curve. Chart paper may be used for several curves. Mark each card with an identification number and each curve with identification letter during testing.

<u>POINTS TO REMEMBER</u>:

1) Spindle set screws must be periodically checked to ensure they are properly tightened.
2) Drum roll's and drill head's revolution per minute should be periodically checked to ensure they remain constant. At present, the rpm of the drum roll is 0.50 revolutions per minute, while the drill head is 120 revolutions per minute.